MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

Faculty of Science, Technology and Architecture, School of Engineering
Department of Mechatronics Engineering
Degree: Bachelor of Technology in Mechatronics Engineering Total Credit: 160
Scheme

	Third Semester						**Fourth Semester**				
Code	**Subject Name**	**L**	**T**	**P**	**C**	**Code**	**Subject Name**	**L**	**T**	**P**	**C**
MEE2001	Engineering Economics	3	0	0	3	MAS21XX	Statistics & Probability	3	0	0	3
MBB2101	Management of Technology	3	0	0	3	MCE2201	Kinematics and Dynamics of Machines	3	1	0	4
MCE2101	Linear Integrated Circuits	3	1	0	4	MCE2202	Sensors and Control Systems	3	1	0	4
MCE2102	Embedded Controllers	3	1	0	4	MCE22XX	Flexi Core 2	3	1	0	4
MCE2103	Strength of Materials	3	0	0	3	MCE22XX	Program Elective 1	3	0	0	3
MCE21XX	Flexi Core 1	3	1	0	4	MCE20XX	Open Elective 1	3	0	0	3
MCE2130	Embedded Controllers Lab	0	0	2	1	MCE2230	Sensors and Control Systems Lab	0	0	2	1
MCE2131	PLC Lab	0	0	4	2	MCE2231	Integrated Electronics Lab	0	0	2	1
MCE2170	Project-based Learning-1	0	0	2	1	MCE2270	Project-based Learning-2	0	0	2	1
	Total Contact Hours (L+T+P)	**18**	**3**	**8**	**25**		**Total Contact Hours (L+T+P)**	**18**	**3**	**6**	**24**
	Fifth Semester						**Sixth Semester**				
Code	**Subject Name**	**L**	**T**	**P**	**C**	**Code**	**Subject Name**	**L**	**T**	**P**	**C**
MCE3101	Design of Machine Elements	3	1	0	4	MCE3201	Drives and Automation	3	1	0	4
MCE3102	Robotics	3	0	0	3	MCE32XX	Program Elective 4	3	0	0	3
MCE31XX	Flexi Core 3	3	1	0	4	MCE32XX	Program Elective 5	3	0	0	3
MCE31XX	Program Elective 2	3	0	0	3	MCE32XX	Program Elective 6	3	0	0	3
MCE31XX	Program Elective 3	3	0	0	3	MCE30XX	Open Elective 3	3	0	0	3
MCE30XX	Open Elective 2	3	0	0	3	MCE3202	Professional Practice	0	0	2	1
MCE3130	Design and Modelling Lab	0	0	2	1	MCE3230	Robotics Lab	0	0	2	1
MCE3131	Pneumatics and Hydraulics Lab	0	0	4	2	MCE3231	Drives and Automation Lab	0	0	2	1
MCE3170	Project-based Learning-3	0	0	2	1	MCE3270	Project-based Learning-4	0	0	3	3
	Total Contact Hours (L+T+P)	**18**	**2**	**6**	**24**		**Total Contact Hours (L+T+P)**	**15**	**1**	**6**	**22**
	Seventh Semester						**Eighth Semester**				
Code	**Subject Name**	**L**	**T**	**P**	**C**	**Code**	**Subject Name**	**L**	**T**	**P**	**C**
MCE41XX	Program Elective 7	3	0	0	3	MCE4270	Major Project	0	0	0	12
MCE41XX	Program Elective 8	3	0	0	3						
MCE40XX	Open Elective 4	3	0	0	3						
MCE40XX	Open Elective 5	3	0	0	3						
MCE4170	Internship (Industry or Research)	0	0	2	1						
	Total Contact Hours (L+T+P)	**12**	**0**	**2**	**13**		**Total Contact Hours (L+T+P)**	**0**	**0**	**0**	**12**

MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

Faculty of Science, Technology and Architecture, School of Engineering
Department of Mechatronics Engineering
Degree: Bachelor of Technology in Mechatronics Engineering Total Credit: 160
Scheme

List of Flexi Core Course

Flexi Core 1	Flexi Core 2	Flexi Core 3
MCE2120: Manufacturing Process **CSE21XX:** Data Structures and Algorithms	**MCE2220:** Fluid Mechanics **CSE22XX:** Object Oriented Programming	**MCE3121:** Flexible Manufacturing System **CSE31XX:** Relational Database Management Systems **MCE3120:** Robot Path Planning and Control

List of Program Electives Courses

IV	V	VI	VII
PE1 • **MCE2240:** Digital System Design • **MCE2241:** IOT Systems	**PE2** • **MCE3140:** Finite Element Methods • **MCE3141:** Signals and Systems **PE3** • **MCE3150:** Advance Control Theory • **MCE3151:** Cyber-Physical System • **MCE3152:** Mobile Robots	**PE 4** • **MCE3240:** Optimal Control • **MCE3241:** Building Automation **PE5** • **MCE3250:** MEMS and NEMS • **MCE3251:** Artificial Intelligence **PE6** • **MCE3260:** Wireless Sensor Networks • **MCE3261:** Machine Vision • **MCE3262:** Production and Operations Management	**PE 7** • **MCE4140:** Farming Automation • **MCE4141:** Electric Vehicles • **MCE4142:** Additive Manufacturing **PE8** • **MCE4150:** industrial IOT • **MCE4151:** Intelligent Systems • **MCE4152:** Collaborative Robots

List of Open Electives Courses

Graded OE	Non-Graded OE
OE1 MCE0001: Fundamental of Robotics **OE2 MCE0002:** Automation in Industry **OE3 MCE0003:** Introduction to Building Automation **OE4 MCE0004:** Sensor Technologies **OE5 MCE0005:** Smart Agriculture	

Degree: Bachelor of Technology in (Hons) Mechatronics Engineering
Total Credit: 178 (160 + 18*)
Scheme

	Third Semester						Fourth Semester				
Code	Subject Name	L	T	P	C	Code	Subject Name	L	T	P	C
MEE2001	Engineering Economics	3	0	0	3	MAS21XX	Statistics & Probability	3	0	0	3
MBB2101	Management of Technology	3	0	0	3	MCE2201	Kinematics and Dynamics of Machines	3	1	0	4
MCE2101	Linear Integrated Circuits	3	1	0	4	MCE2202	Sensors and Control Systems	3	1	0	4
MCE2102	Embedded Controllers	3	1	0	4	MCE22XX	Flexi Core 2	3	1	0	4
MCE2103	Strength of Materials	3	0	0	3	MCE22XX	Program Elective 1	3	0	0	3
MCE21XX	Flexi Core 1	3	1	0	4	MCE20XX	Open Elective 1	3	0	0	3
MCE2130	Embedded Controllers Lab	0	0	2	1	MCE2230	Sensors and Control Systems Lab	0	0	2	1
MCE2131	PLC Lab	0	0	4	2	MCE2231	Integrated Electronics Lab	0	0	2	1
MCE2170	Project-based Learning-1	0	0	2	1	MCE2270	Project-based Learning-2	0	0	2	1
	Total Contact Hours (L+T+P)	**18**	**3**	**8**	**25**		**Total Contact Hours (L+T+P)**	**18**	**3**	**6**	**24**
	Fifth Semester						**Sixth Semester**				
Code	Subject Name	L	T	P	C	Code	Subject Name	L	T	P	C
MCE3101	Design of Machine Elements	3	1	0	4	MCE3201	Drives and Automation	3	1	0	4
MCE3102	Robotics	3	0	0	3	MCE32XX	Program Elective 4	3	0	0	3
MCE31XX	Flexi Core 3	3	1	0	4	MCE32XX	Program Elective 5	3	0	0	3
MCE31XX	Program Elective 2	3	0	0	3	MCE32XX	Program Elective 6	3	0	0	3
MCE31XX	Program Elective 3	3	0	0	3	MCE30XX	Open Elective 3	3	0	0	3
MCE30XX	Open Elective 2	3	0	0	3	MCE3202	Professional Practice	0	0	2	1
MCE3130	Design and Modelling Lab	0	0	2	1	MCE3230	Robotics Lab	0	0	2	1
MCE3131	Pneumatics and Hydraulics Lab	0	0	4	2	MCE3231	Drives and Automation Lab	0	0	2	1
MCE3170	Project-based Learning-3	0	0	2	1	MCE3270	Project-based Learning-4	0	0	3	3
MCE3181	Research Methodology	1	0	0	1	MCE328X*	Honors Elective1	3	0	0	3
	Total Contact Hours (L+T+P)	**18**	**2**	**8**	**25**		**Total Contact Hours (L+T+P)**	**18**	**1**	**6**	**25**
	Seventh Semester						**Eighth Semester**				
Code	Subject Name	L	T	P	C	Code	Subject Name	L	T	P	C
MCE41XX	Program Elective 7	3	0	0	3	MCE4270	Major Project	0	0	0	12
MCE41XX	Program Elective 8	3	0	0	3	MCE428X*	Honors Project	0	0	0	8
MCE40XX	Open Elective 4	3	0	0	3						
MCE40XX	Open Elective 5	3	0	0	3						
MCE4170	Internship (Industry or Research)	0	0	2	1						
MCE418X*	Honors Elective 2	3	0	0	3						
MCE418X*	Honors Elective 3	3	0	0	3						
	Total Contact Hours (L+T+P)	**18**	**0**	**2**	**19**		**Total Contact Hours (L+T+P)**	**0**	**0**	**0**	**20**

Degree: Bachelor of Technology in (Hons) Mechatronics Engineering
Total Credit: 178 (160 + 18*)
Scheme

List of Flexi Core Course

Flexi Core 1	Flexi Core 2	Flexi Core 3
MCE2120: Manufacturing Process **CSE21XX**: Data Structures and Algorithms	**MCE2220:** Fluid Mechanics **CSE22XX**: Object Oriented Programming	**MCE3120:** Flexible Manufacturing System CSE31XX Relational Database Management Systems **MCE3121:** Robot Path Planning and Control

List of Program Electives Courses

IV	V	VI	VII
PE1 • **MCE2240:** Digital System Design • **MCE2241:** IOT Systems	**PE2** • **MCE3140:** Finite Element Methods • **MCE3141:** Signals and Systems **PE3** • **MCE3150:** Advance Control Theory • **MCE3151:** Cyber-Physical System • **MCE3152:** Mobile Robots	**PE 4** • **MCE3240:** Optimal Control • **MCE3241:** Building Automation **PE5** • **MCE3250:** MEMS and NEMS • **MCE3251:** Artificial Intelligence **PE6** • **MCE3260:** Wireless Sensor Networks • **MCE3261:** Machine Vision • **MCE3262:** Production and Operations Management	**PE 7** • **MCE4140:** Farming Automation • **MCE4141:** Electric Vehicles • **MCE4142:** Additive Manufacturing **PE8** • **MCE4150:** industrial IOT • **MCE4151:** Intelligent Systems • **MCE4152:** Collaborative Robots

List of Open Electives Courses

Graded OE	Non-Graded OE
OE1 MCE0001: Fundamental of Robotics **OE2 MCE0002:** Automation in Industry **OE3 MCE0003:** Introduction to Building Automation **OE4 MCE0004:** Sensor Technologies **OE5 MCE0005:** Smart Agriculture	

List of Program Electives for Hons.

VI / VII
MCE3281: Robotics and its Control – **Pre-Requisite:** Nil **MCE4181:** Smart Manufacturing – **Pre-Requisite:** (Manufacturing Process course offered as Flexi core -1 and Flexible Manufacturing System course offered as Flexi core -3 by Mechatronics Department) **MCE4182:** AI-based Controllers **Pre-Requisite:** Nil

Degree: B. Tech Mechatronics Engineering with Minor Specialization in Robotics
Total Credit: 178 (160 + 18*)

	Fifth Semester						Sixth Semester				
Code	Subject Name	L	T	P	C	Code	Subject Name	L	T	P	C
MCE3190	Research Methodology	0	0	1	1	MCE329X*	Minor Elective 1	3	0	0	3
	Seventh Semester						**Eighth Semester**				
Code	Subject Name	L	T	P	C	Code	Subject Name	L	T	P	C
MCE419X*	Minor Elective 2	3	0	0	3	MCE4271*	Minor Specialization Project	0	0	0	8
MCE419X*	Minor Elective 3	3	0	0	3						

List of Program Electives Program Electives for Minor Specialization

VI / VII
MCE3290: Robotics and its Control - Pre-Requisite-(**Fundamental of Robotics** course offered as OE1 by Mechatronics Department) MCE4191: Wheeled Robots, Pre-Requisite-Nil MCE4192: Advance Robotics and Applications, Pre-Requisite-Nil

Eligibility Criteria for Minor Specialization[i]

SN	Minor Program	Eligible Branch of Students	@ Offering Department	Award of Degree
1	Robotics	All (Except Mechanical Engineering and Electronics & Communication Engineering)	Mechatronics	B. Tech. in **"branch"** name with Minor in Robotics

[i] For Eligibility criteria, refer the AICTE APH.

Degree: Bachelor of Technology in Mechatronics Engineering
Total Credit: 160 & 178
Details Syllabus

MCE3101 DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Basic Concepts: Fundamentals of Mechanical Design: The Design Process, Economics of Design, Reliability, Safety and Product Liability, Codes and Standards, Types of Materials, Stress-Strain Response, Types of Loads and Stresses, Failure Modes, Factor of Safety, Strength Design. Static And Variable Stress Analysis: Static Strength, Failure Theories, Stress Concentration, Fatigue Strength, Stress-Life (S-N) Diagram, High Cycle Fatigue, Endurance Limit Modifying Factors, Effect of Mean Stress, Fluctuating Stresses, and Stresses due to Combined Loading. Design For Static and Fatigue Load, Coil Springs: Helical Coil Spring: Compression Springs of Round/Square/Rectangular Wires, Spring Materials, Stress and Deflection of Spring Subjected to Steady, Fluctuating and Impact Loads, Spring Surge and Buckling, Concentric Springs. Gears: Spur and Helical Gears: Merits, Terminology, Tooth Profile, Pressure Angle, Lewis Equation for Beam Strength, Form Factor, Velocity Factor, Design for Static Loads, Design for Dynamic and Wear Loads. Design For Static and Fatigue Load, ASME Code for Shaft Design.

Reference books:

1. J. E. Shigley and C. R. Mischke, *Mechanical Engineering Design*, 7th ed. New York, NY, USA: McGraw-Hill, 2003.
2. R. L. Norton, *Machine Design—An Integrated Approach*, 5th ed. Boston, MA, USA: Pearson, 2013.
3. U. C. Jindal, *Machine Design*, 1st ed. New Delhi, India: Pearson, 2010.
4. V. B. Bhandari, *Design of Machine Elements*, 3rd ed. New Delhi, India: Tata McGraw-Hill Education, 2010.

MCE 3102 ROBOTICS [3 0 0 3]

Introduction of robots and its types, degrees of Freedom of robot, Robot Configuration, Specification of a robot; Manipulator Kinematics: Homogeneous Transformations, Forward and Inverse Kinematics, Differential motions and velocity: Differential motions of joints and robot, Jacobians, Dynamics: Euler-Lagrange Equations of Motion, Properties of Robot Dynamics, Robot statics, Trajectory planning: Joint space trajectory planning, Cartesian space trajectory planning. Kinematics of wheeled mobile robots.

Reference books:

1. Y. Kozyhev, *Industrial Robots Handbook*, 2nd ed. Moscow, Russia: MIR Publications, 2020.
2. S. B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, 2nd ed. Hoboken, NJ, USA: Wiley, 2020.
3. S. G. Tzafestas, *Introduction to Mobile Robot Control*. Amsterdam, Netherlands: Elsevier, 2020.
4. M. W. Spong and M. Vidyasagar, *Robot Dynamics and Control*, 2nd ed. Hoboken, NJ, USA: Wiley, 2019.
5. S. K. Saha, *Introduction to robotics*. Tata McGraw-Hill Education, India, 2014.

MCE3120 FLEXIBLE MANUFACTRUING SYSTEM [3 1 0 4]

Types of production, production planning and control, manufacturing in a competitive environment, Automation In Production Systems, Automation Principles and Strategies, Industrial Control Systems, Applications of Sensors and Actuators, ADC/DAC, CNC Technology, Robot Intelligence, Material Handling and Transport Systems, Storage Systems, Manufacturing Cells, Group Technology and Cellular Manufacturing, FMS Components, Quantitative Analysis Of FMS Systems, Petri Networks,

Automated Assembly And Inspection. FMS computer hardware and software, general structure and requirements, PLCs, FMS installation and implementation, acceptance testing. Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems.

Reference books:

1. H. K. Shivanand, M. M. Benal, and V. Koti, *Flexible Manufacturing System*, 2nd ed. New Delhi, India: New Age International Pvt Ltd, Dec. 2021.
2. M. P. Groover, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 5th ed. Hoboken, NJ, USA: Pearson, Jul. 2021.
3. S. Kalpakjian and S. R. Schmid, *Manufacturing Engineering and Technology*, 7th ed. Boston, MA, USA: Pearson, 2014.

CSE2102 RELATIONAL DATABASE MANAGEMENT SYSTEMS [3 1 0 4]

Introduction: DBMS Concepts, Database System Vs File System, Data Models, Schema & Instance, Schema architecture, Data independence, Data Base Languages and interfaces, Database system applications, Database users, Functions of DBA Data Modeling using the Entity Relationship; Model: ER model concepts, Entities, Attributes, Relationship & types, Relationship Constraints, Extended ER-Model Concept - Generalization, Specialization and Aggregation, Transforming ER diagram into the tables; Relational Data models: Domains, Tuples, Attributes, Relations, Characteristics of relations, Keys, Key attributes of relation, Relational database, Schemas, Integrity constraints. Referential integrity, Relational Algebra and Relational Calculus; Relational algebra operators: Unary, Binary, Set Operations. Tuple oriented and domain oriented relational calculus and its operations; SQL: Basic SQL Query, Creating Table and Views, SQL as DML, DDL and DCL, SQL Algebraic Operations, Joins, Sub-Queries, Aggregate Operations, Cursors, Dynamic SQL, Integrity Constraints in SQL, Triggers; Data Base Design: Introduction to Normalization, Functional dependency, Normal forms, Decomposition, Armstrong's Axioms, Canonical Cover, Lossless Join & Dependency preservation Problems with null valued and dangling tuples, multivalued dependencies; Transaction Processing Concepts: Transaction Properties & States, Schedules, Serial & Concurrent Schedule, Serializability of schedules, conflict & view serializable schedule, Recoverability, Recovery from transaction failures, log-based recovery, checkpoints, Deadlock handling; Concurrency Control Techniques: Concurrency control, Concept of Locks, Concurrency Control Protocols - Two Phase Locking Protocols, Time stamping protocols, validation-based protocol, multiple granularities, Multi version schemes, Recovery with concurrent transactions; File Structures: File Organization, Indexing, Primary, Clustered, Secondary Indexes, Hashing, Multilevel Indexing with B-Tree, B+ Tree.

Reference books:

1. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts*, 6th ed. New York, NY, USA: McGraw-Hill, 2013.
2. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 6th ed. Boston, MA, USA: Addison-Wesley, 2010.
3. R. Ramakrishnan and J. Gehrke, *Database Management Systems*, 3rd ed. New York, NY, USA: McGraw-Hill, 2014.
4. Bayross, *SQL, PL/SQL: The Programming Language of Oracle*, 4th ed. New Delhi, India: BPB Publications, 2010.

5. C. J. Date, *An Introduction to Database Systems*, 8th ed. New Delhi, India: Prentice Hall of India, 2006.

MCE3121 ROBOT PATH PLANNING AND CONTROL [3 1 0 4]

Configuration space, obstacles space, dimensions, topology, parameterization, transformations, potential functions, obstacle avoidance, gradient descent, local minima problem, navigational potential functions, non-Euclidean potential functions, algorithms, analysis, running time, complexity, completeness. Graph Search A*, Generalized Voronoi Graph (GVG), opportunist path planning, cell decomposition, trapezoidal, Morse cell, visibility-based decompositions. Sampling-based algorithms, the Probabilistic Road Map (PRM), Rapidly Exploring Random Trees (ERT), control-based planning.

Reference books:

1. F. Fahimi, *Autonomous Robots: Modeling, Path Planning, and Control*, 1st ed. Berlin, Germany: Springer, 2009.
2. H. Asada and J. J. Slotine, *Robot Analysis and Control*. Berlin, Germany: Springer-Verlag, 1998.
3. Y. B. Sebbane, *Planning and Decision Making for Aerial Robots*, 1st ed. Cham, Switzerland: Springer, 2014.
4. H. Choset and K. M. Lynch, *Principles of Robot Motion: Theory, Algorithms, and Implementations*, 1st ed. Boston, MA, USA: MIT Press, 2005.

MCE3140 FINITE ELEMENT METHODS [3 0 0 3]

Introduction to FEM: Overview of FEM, basic steps, and applications, Mathematical Foundations: Strong and weak formulations, variational methods, and element types, 1D Finite Element Analysis: Stiffness matrices, boundary conditions, applications to trusses and beams, 2D Finite Element Analysis: Shape functions, plane stress/strain, applications in structural analysis and heat conduction, 3D Finite Element Analysis: 3D elements, stiffness matrices, applications in structural analysis, case studies

Reference books:

1. J. N. Reddy, *An Introduction to the Finite Element Method*, 4th ed. New York, NY, USA: McGraw-Hill, 2019.
2. S. S. Rao, *The Finite Element Method in Engineering*, 6th ed. Oxford, UK: Butterworth-Heinemann, 2018.
3. O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu, *The Finite Element Method: Its Basis and Fundamentals*, 7th ed. Oxford, UK: Butterworth-Heinemann, 2013.
4. R. D. Cook et al., *Concepts and Applications of Finite Element Analysis*, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, 2002.

MCE3141 SIGNALS AND SYSTEMS [3 0 0 3]

Introduction: Definitions, Overview of specific systems, Classification of signals, Basic operations on signals, Elementary signals and functions, Systems viewed as interconnections of operations, properties of systems. Time domain representations for linear time-invariant systems: Introduction, Convolution: Impulse response representation for LTI systems, properties of the impulse response

representation for LTI systems, Differential and difference equation representations for LTI systems, S-domain transformation using Laplace transform, Fourier representation for signals: The discrete-time Fourier series, continuous-time periodic signals: Discrete-time non-periodic signals: The discrete-time Fourier transform, Z-Transform, The Fourier transform, properties of Fourier representations, Fast Fourier transform. Signal processing in MATLAB.

Reference books:

1. R. Babu, *Signals & Systems*, 4th ed. Chennai, India: Scitech Publications, 2011.
2. S. Haykin and B. V. Veen, *Signals and Systems*, 2nd ed. New Delhi, India: John Wiley & Sons, 2002.
3. J. G. Proakis, D. G. Manolakis, and D. Mimitris, *Introduction to Digital Signal Processing*, 4th ed. New Delhi, India: Prentice Hall, 2006.

MCE3150 ADVANCE CONTROL THEORY [3 0 0 3]

Non-Linear System- Phase Plane Analysis, Linearization, Describing Function method, Limit Cycle, Controllability and Observability of Non-Linear System, Lyapunov Stability, Kalman Filter, Sliding Mode Control, System Identification, Control Algorithms for MIMO System-Robust, Optimal and Adaptive Control, Robotic Applications- State observation and feedback control in robotic system.

Reference books:

1. R. Burns, Advanced Control Engineering, 1st ed. Oxford, UK: Butterworth-Heinemann, 2001.
2. M. Athans and P. L. Falb, Optimal Control: An Introduction to the Theory and Its Applications, reprint ed. Mineola, NY, USA: Dover Publications, 2006.
3. U. Mackenroth, *Robust Control Systems: Theory and Case Studies*. Berlin, Germany: Springer Berlin Heidelberg, 2004.
4. T. J. Tarn, *Control in Robotics and Automation: Sensor-Based Integration*. Oxford, UK: Academic Press, 2011.

MCE3151 CYBER PHYSICAL SYSTEM [3 0 0 3]

Cyber-Physical Systems (CPS) in the real world, basics of cyber physical system, components of cyber physical system, wireless sensor network, control of CPS: event triggered control, distributed control, control challenges; networked control system (NCS), security of cyber physical systems, case studies.

Reference books:

1. E. A. Lee and S. A. Seshia, *Introduction to Embedded Systems: A Cyber-Physical Systems Approach*, Latest ed. United Kingdom: MIT Press, 2017.
2. R. Alur, *Principles of Cyber-Physical Systems*, Latest ed. Cambridge, MA, USA: MIT Press, 2015.
3. M. Wolf, *High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing*, Latest ed. Amsterdam, Netherlands: Elsevier Science, 2014.
4. D. B. Rawat, S. Jeschke, and C. Brecher, *Cyber-Physical Systems: Foundations, Principles, and Applications*, Latest ed. Amsterdam, Netherlands: Elsevier Science, 2016.

MCE3152 MOBILE ROBOTS [3 0 0 3]

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability; Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, Control theory - Control design basics, Cruise-Controllers, Performance Objectives. Simple robot - State space model, Linearization, LTI system, stability. PID control, basic control algorithms, Sensors for mobile robots - Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors.

Reference books:

1. R. Siegwart and I. R. Nourbakhsh, *Introduction to Autonomous Mobile Robots*. Cambridge, MA, USA: The MIT Press, 2011.
2. P. Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Springer Tracts in Advanced Robotics, 2011.
3. S. Thrun, W. Burgard, and D. Fox, *Probabilistic Robotics*. Cambridge, MA, USA: MIT Press, 2005.
4. E. R. Melgar and C. C. Diez, *Arduino and Kinect Projects: Design, Build, Blow Their Minds*, 2012.

MCE0002 AUTOMATION IN INDUSTRY [3 0 0 3]

Automation yardstick, Areas of automation -Production fundamentals - Methods, tooling and operations - Pre-automation activities - How-to-do-Automation - Anatomy of automation - Information and feedback. The control system - Modes and types of control - Controllers and computers - Automation philosophy - Cybernetics and information theory - Automation trends.

Reference Books:

1. M. P. Grover, *Automation, Production Systems, and Computer Integrated Manufacturing*. Upper Saddle River, NJ, USA: Pearson Education, Latest ed, 2016.
2. J. Webb, *Principles and Applications of PLC*, New York, NY, USA: McMillan, 1992.
3. T. C. Chang and R. A. Wysk, *An Introduction to Automated Process Planning Systems*. Englewood Cliffs, NJ, USA: Prentice Hall, 1984.
4. G. Amber and P. S. Amber, *Anatomy of Automation*. Upper Saddle River, NJ, USA: Prentice Hall, Latest ed., 1963

MCE3130 DESIGN AND MODELLING LAB [0 0 2 1]

Introduction of 2D model design and 3D CAD parametric design; CREO parametric design: Sketch, Part modelling, Surface modelling, Dimensions and annotation; Assembly; Advanced assembly; Multi-view drawing and reading; Animation; Mechanical part design; Robotic arm part design.

Reference books:

1. Zeid, *CAD/CAM: Theory and Practice*, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2012.
2. R. H. Shih, *Parametric Modeling with Creo Parametric 11.0*. Schaumburg, IL, USA: SDC Publications, 2024.

MCE 3131 PNEUMATICS AND HYDRAULICS LAB [0 0 4 2]

Operations of various valves like directional control valves, flow control, valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters.

Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches. Working principles of hydraulic pumps, hydraulic motors, throttle valves, direction control valves. Manual and electro-hydraulic circuits using above components. Manual and electro-hydraulic circuits using above components.

Reference books:

1. E. Anthony, *Fluid Power with Applications*. New York, NY, USA: Pearson Education, 2003.
2. S. R. Majumdar, *Pneumatic Systems: Principles and Maintenance*. New Delhi, India: Tata McGraw-Hill, 2000.
3. E. A. Parr, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, 3rd ed. Oxford, U.K.: Butterworth-Heinemann, 2011.
4. J. Parambath, *Design of Industrial Hydraulic Systems: In the SI Units*. Independently published, 2020.

MCE 3170 PROJECT BASED LEARNING III [0 0 2 1]

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

MCE3201 DRIVES AND AUTOMATION [3 1 0 4]

Introduction to power switches and power converters, components of electric drives, factors affecting choice of drives, fundamental torque equation, speed-torque conventions, multi-quadrant operation of electric drives, speed control of DC motors, induction motors, Servo motors, BLDC motors and Stepper motors, electric braking, Automation Hierarchy and basic component of automation system, introduction to Sequence Control, PLCs and Relay Ladder Logic, PLC integration with Pneumatic and Hydraulic systems.

Reference books:

1. G. K. Dubey, *Fundamentals of Electric Drives*, 2nd Ed., Narosa Publishers, 2010.
2. J. Nagrath and D. P. Kothari, *Electric machines*, 5th Ed., Tata McGraw Hill, 2017.
3. John W. Webb and Ronald A. Reis, *Programmable Logic Controllers: Principles and Application*, 5th Ed., Pearson, 2017.
4. Katsuhiko Ogata, *Modern Control Engineering*, 5th Ed., Pearson, 2011.
5. P. A. Andrew, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, 2nd Ed Butterworth Heinemann, 2011.

MCE3240 OPTIMAL CONTROL [3 0 0 3]

Introduction, optimal control of discrete-time systems, discrete-time linear quadratic regulator, optimal control of continuous-time systems, continuous-time linear quadratic regulator, tracking problem, discrete-time tracking problem, final-time-free and constrained input control, dynamic

programming, bellman's principle of optimality, LQG, reinforcement learning and optimal adaptive, case studies.

Reference book:

1. B. D. O. Anderson and J. B. Moore, *Optimal Control: Linear Quadratic Methods*. Mineola, NY, USA: Dover Publications, 2007.
2. F. L. Lewis, D. Vrabie, and V. L. Syrmos, *Optimal Control*. Hoboken, NJ, USA: Wiley & Sons, 2012.
3. L. M. Hocking, *Optimal Control: An Introduction to the Theory with Applications*. Oxford, UK: Clarendon Press, 1991.

Degree: Bachelor of Technology in Mechatronics Engineering
Total Credit: 160 & 178
Details Syllabus

MCE3242 BUILDING AUTOMATION [3 0 0 3]

Overview of Building Automation System (BAS), Importance and benefits of BAS, Components of a BAS, Sensors and actuators for building automation; Energy Management Systems (EMS)- Overview of energy management, Role of BAS in energy conservation, Monitoring and controlling energy usage; Building Automation Software; Smart Buildings and IoT Integration- Introduction to smart buildings, Internet of Things (IoT) in building automation, Future trends in building automation.

Reference books:

1. B. A. Srney, L. Capehart, and T. Middelkoop, *Introduction to Building Automation Systems (BASS)*, Taylor & Francis, 2020.
2. H. Merz, T. Hansemann, and C. Hubner, *Building Automation: Communication Systems with EIB/KNX, LON, and BASC net*, 2ed, 2018.
3. R. A. Panke, *Energy Management Systems & Direct Digital Control*, Taylor & Francis, 2020.

MCE3250 MEMS AND NEMS [3 0 0 3]

Introduction to MEMS and NEMS and Microsystems: Evolution of micro and nano fabrication, microelectronics, application in the automotive and other industries; Materials for MEMS and NEMS: Substrates and wafers, Packaging materials; Micro and Nano fabrication Processes: Lithography processes, Ion implantation, Diffusion, Oxidation, Chemical and Physical fabrication process, Deposition by Epitaxy, Etching, Surface micromachining. Working principles of Microsystems; Micro and Nano sensors; Micro and Nano actuators; Scaling laws in miniaturization: Scaling in geometry, Scaling in rigid body dynamics, Scaling in electrostatic, electromagnetic forces, Scaling in electricity, Scaling in heat transfer and fluid mechanics.

Reference books:

1. T. R. Hsu, *MEMS and Microsystems: Design and Manufacturing*, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2008.
2. C. Liu, *Foundations of MEMS*, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2012.
3. M. J. Madou, *Fundamentals of Microfabrication: The Science of Miniaturization*, 2nd ed. Boca Raton, FL, USA: CRC Press, 2002.
4. W. Menz, J. Mohr, and O. Paul, *Microsystem Technology*. Weinheim, Germany: Wiley-VCH, 2008.

MCE3252 ARTIFICIAL INTELLIGENCE [3 0 0 3]

Introduction to AI and intelligent agents. Uninformed search, Heuristic search, stochastic search, adversarial search, game playing. Machine Learning: basic concepts, linear models, perceptron, neural network, naive bayes, Decision trees, ensemble, logistic regression, and unsupervised learning. Constraint satisfaction problems, Markov decision processes, reinforcement learning. Logical agents, propositional logic and first order logic, planning, partial order planning, Bayesian Networks, natural language processing, AI applications.

Reference Books

1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2015.

2. K. Knight, E. Rich, and B. Nair, *Artificial Intelligence*, 3rd ed. New York, NY, USA: McGraw-Hill Education, 2012.
3. D. W. Patterson, *Introduction to AI and Expert Systems*. Upper Saddle River, NJ, USA: Pearson Education, 2007.
4. G. F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*. New Delhi, India: Pearson Education Asia, 2009.

MCE3260 WIRELESS SENSOR NETWORK [3 0 0 3]

Introduction, Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, system power management, case studies.

Reference book:

1. H. Karl and A. Willig, *Protocols and Architectures for Wireless Sensor Networks*. Hoboken, NJ, USA: John Wiley & Sons, 2005.
2. F. Zhao and L. J. Guibas, *Wireless Sensor Networks: An Information Processing Approach*. San Mateo, CA, USA: Elsevier, 2004.
3. K. Sohraby, D. Minoli, and T. Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*. Hoboken, NJ, USA: John Wiley & Sons, 2007.
4. W. Stallings, *Wireless Communications and Networks*. Upper Saddle River, NJ, USA: Pearson Education, 2005.

MCE3261 MACHINE VISION [3 0 0 3]

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. 3D Vision: Camera and optics, Perspective Projection Geometry Rotation and translation matrix, Pinhole camera model, Calibration methods, Intrinsic and Extrinsic Camera Parameters, Stereovision, Stereo correspondence Algorithms, Epipolar Geometry, Essential and fundamental matrix, 3D Reconstruction. Motion Estimation and Tracking: Optical Flow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies and basic applications.

Reference books:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2008.
2. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 2nd ed. Boston, MA, USA: PWS Publishing, 1998.
3. B. Cyganek and J. P. Siebert, *An Introduction to 3D Computer Vision Techniques and Algorithms*, 1st ed. Hoboken, NJ, USA: Wiley, 2009.
4. E. R. Davies, *Machine Vision: Theory, Algorithms, and Practicalities*, 3rd ed. London, UK: University of London, 2004.

MCE3262 PRODUCTION AND OPERATION MANGEMENT [3 0 0 3]

Operations Strategy in a global economy, Operations Management and Productivity, Types and Characteristics of Manufacturing and Service Systems, Product Design. Introduction to Forecasting, Introduction to Time-series forecasts, Extrapolative methods Causal Methods of forecasting, Qualitative Methods of Forecasting, Introduction to Inventory Management, Various costs involved in inventory management, Models of Inventory Management, Various variations of EOQ, Inventory Models with Uncertain Demand, Inventory Models with Uncertain Demand, Miscellaneous Systems and Issues, Inventory Control and Supply Chain Management, Nature of Quality, Evolution of Quality Management, Modern Quality Management, Total Quality Management, Statistical Concepts in Quality Control, Acceptance Sampling, 7 QC Tools, Service Facility Layout, JIT Manufacturing, Lean Manufacturing, Kanban Production System, Case Discussions on JIT and Lean Philosophy. Maintenance Management, Total Productive Maintenance, Introduction to Project Management, PERT and CPM.

Reference books:

1. W. J. Stevenson, *Operations and Supply Chain Management*, 14th ed. New York, NY, USA: McGraw-Hill, 2025.
2. N. Gaither and G. Frazier, *Operations Management*, 9th ed. Boston, MA, USA: South-Western/Thomson Learning, 2002.
3. R. B. Chase and F. R. Jacobs, *Operations Management for Competitive Advantage*, 11th ed. New York, NY, USA: McGraw-Hill/Irwin, 2005.

Degree: Bachelor of Technology in Mechatronics Engineering
Total Credit: 160 & 178
Details Syllabus

MCE0003 INTRODUCTION TO BUILDING AUTOMATION [3 0 0 3]

Introduction to Building Automation- Overview of Building Automation, History and evolution of BAS, Importance and benefits of BAS, Components of a BAS, Fundamentals of Control Systems- open-loop and closed-loop, Sensors and actuators; Energy Management Systems (EMS)- Overview of energy management, Role of BAS in energy conservation, Monitoring and controlling energy usage; Future trends in building automation.

Reference books:

1. B. A. Srney, L. Capehart, and T. Middelkoop, *Introduction to Building Automation Systems (BASS)*, Taylor & Francis, 2020.
2. H. Merz, T. Hansemann, and C. Hübner, Building Automation: Communication Systems with EIB/KNX, LON, and BACnet, 2nd ed. Berlin, Germany: Springer-Verlag, 2018.
3. R. A. Panke, *Energy Management Systems & Direct Digital Control*, Taylor & Francis, 2020.

MCE3202 PROFESSIONAL PRACTICES [0 0 2 1]

MCE 3230 ROBOTICS LAB [0 0 2 1]

Forward and inverse kinematics of a robot, velocity analysis, Mobile robot, Dynamics of Robot Manipulators, Control of Robot Manipulators: PID control, Adaptive Control, Robot Path-Planning.

Reference book:

1. Y. Kozyhev, *Industrial Robots Handbook*, Moscow, Russia: MIR Publications, 2022.
2. S. B. Niku, *Introduction to Robotics: Analysis, Control Applications*, NJ, USA: Wiley Publications, 2020.
3. S. G. Tzafestas, *Introduction to Mobile Robot Control*. Amsterdam, Netherlands: Elsevier, 2013.
4. M. W. Spong and M. Vidyasagar, *Robot Dynamics and Control*, 2nd ed. Hoboken, NJ, USA: Wiley Publications, 2009.

MCE3231 DRIVES AND AUTOMATION LAB [0 0 2 1]

Power converters and their operational characteristics, Control of Drives: DC motors, induction motors, BLDC motor, stepper motor, servo motor, PLC integration with pneumatic and hydraulic system and their control, implementation of PID control using PLC.

Reference books:

1. G. K. Dubey, *Fundamentals of Electric Drives*, 2nd Ed., Narosa Publishers, 2010.
2. J. Nagrath and D. P. Kothari, *Electric machines*, 5th Ed., Tata McGraw Hill, 2017.
3. John W. Webb and Ronald A. Reis, *Programmable Logic Controllers: Principles and Application*, 5th Ed., Pearson, 2017.
4. Katsuhiko Ogata, *Modern Control Engineering*, 5th Ed., Pearson, 2011.
5. P. A. Andrew, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, 2nd Ed Butterworth Heinemann, 2011.

MCE3170 PROJECT BASED LEARNING IV [0 0 3 3]

Degree: Bachelor of Technology in Mechatronics Engineering
Total Credit: 160 & 178
Details Syllabus

Project-based learning involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of Project based learning is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, Project based learning takes students through the following phases or steps: Identifying a problem, agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution), Designing and developing a prototype of the solution, refining the solution based on feedback from experts, instructors, and/or peers. Depending on the goals of the instructor, the size and scope of the project can vary greatly.

MCE4140 FARMING AUTOMATION [3 0 0 3]

Introduction to agricultural automation, overview of AI applications in modern farming, importance of automation in addressing food security and sustainability, precision farming with AI, AI-based tools for soil analysis and monitoring. Drones and sensors for crop management, predictive analytics for crop yield, image recognition techniques for detecting pests and plant diseases, real-time pest control and risk management using advance tools, automated agricultural machinery for planting, harvesting, and weeding, robotics in agriculture, sustainable agriculture with AI, applications of agricultural robotics & machine vision systems in crop farming

Reference books:

1. Stephan Hussmann, *Automation in Agriculture: Securing Food Supplies for Future Generations*, 1st Ed., Intechopen, 2018.
2. Avital Bechar, *Innovation in Agricultural Robotics for Precision Agriculture*, 1st Ed., Springer, 2021.
3. Suchandra Dutta, Aditya Sinha and Debabrata Basu, *Role of Artificial Intelligence in Agriculture: Current Scenario and Future Prospects*, 1st Ed., New Delhi Publishers, 2022
4. Wendell Bowers, Benjamin Jones, and Elwood Olver, *Engineering Applications in Agriculture*, 6th Ed., Stipes Publishing, 1986.

MCE4141 Electric Vehicles [3 0 0 3]

Electric Vehicle: Need, Types, Cost and Emissions, layouts, cables, components, batteries for EV's and its types, charging methods and standards, vehicle dynamics, vehicle load forces, gradeability, vehicle acceleration. Motors: types, principle, construction and control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) –Parallel HEDT, Switched Reluctance Motors (SRM) Drives – Basic structure, drive Convertor, design. control system for EV's, power flow control, electronic control unit (ECU), fuel economy of a battery electric vehicle (BEV); Introduction to regenerative braking, vehicle auxiliaries, charging infrastructure, Battery Management System (BMS), Safety Coordination.

Reference books:

1. James Larminie and John Lowry, *Electric Vehicle Technology Explained*, 2nd Ed., Wiley, 2012.
2. Allen Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, 1st Ed., CRC Press, 2017.
3. Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – Fundamentals, Theory, and Design*, 3rd Ed. CRC Press, 2018

4. SWAYAM, "Fundamentals of Electric vehicles: Technology & Economics", https://onlinecourses.nptel.ac.in/noc20_ee99/preview , Accessed on: January 2025.

MCE4142 ADDITIVE MANUFACTURING [3 0 0 3]

Need for Additive Manufacturing, Generic AM process, stereolithography or 3D-printing, rapid prototyping, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology. Additive Manufacturing Process chain: the eight steps in additive manufacture, variations from one AM machine to another, metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas. Photo polymerization processes, Powder bed fusion processes, Extrusion-based systems, Printing Processes evolution of printing as an additive manufacturing process, Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam Deposition Processes and Direct Write Technologies. Guidelines for Process Selection, Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control. Software issues for Additive Manufacturing, Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Reference books:

1. C. Chee Kai and L. Kah Fai, *Rapid Prototyping: Principles & Applications*, World Scientific, 2003.
2. Kamrani and E. Abouel Nasr, *Rapid Prototyping: Theory & Practice*, Springer, 2006.
3. D. T. Pham and S. S. Dimov, *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling*, Springer, 2001.
4. R. Nooran John, *Rapid Prototyping: Principles and Applications in Manufacturing*, Wiley & Sons, 2006.
5. H. Prasad and A. V. Suresh, *Additive Manufacturing Technology*, Cengage, 2019.

MCE4150 INDUSTRIAL IoT [3 0 0 3]

Introduction to machine to machine (M2M) communication and IoT, An emerging industrial structure for IoT, IoT system architecture, IoT reference model, IoT deployment and operational view, IoT physical devices and endpoints, Communication and networking protocols-MQTT and AMQP protocols, IoT enabling technologies-RFID, WSN,SCADA etc., Analytics for the IoT, Applying the geospatial analytics to IoT data, Real world design constraint, Technical design constraint, Future internet design for various IoT use cases such as smart cities, smart environments, smart homes, smart health etc.

Reference books:

1. J. Holler, V. Tsiatsis, C. Mulligan, K. Karnouskos, and D. Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, 1st ed., Elsevier, 2014.
2. Bahga and V. Madisetti, *Internet of Things-A Hands on Approach*, 1st ed., Orient Blackswan Private Limited, 2015.

3. R. O., M. N., D. Sanchez, and A. Aryasomajula, *Internet of Things and Data Analytics Handbook*, 1st ed., Wiley-Blackwell, 2017.
4. Y. Patil, *Azure IoT Development Cookbook*, 1st ed., Packt Publishing Ltd, 2017.

MCE4151 INTELLIGENT SYSTEMS [3 0 0 3]

Intelligent agent, structure and architecture of agents, basic elements of fuzzy systems, fuzzification, Fuzzy inference, Supervised learning, gradient methods, reinforcement learning, unsupervised learning, deep Learning, applications: adaptive control, self-tuning PID controllers, cooperative Intelligence, characteristics of cooperative intelligence, Adaptive Algorithms, Metaheuristic Algorithms, Nature and Bio Inspired Algorithms.

Reference books:

1. S. S. V. C. and A. Hareendran, *Artificial Intelligence and Machine Learning*, 1st ed. New Delhi, India: PHI Learning Pvt. Ltd., 2014.
2. T. J. Ross, *Fuzzy Logic with Engineering Applications*, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, Ltd., 2016.
3. C. M. Bishop, *Pattern Recognition and Machine Learning*, 1st ed. New York, NY, USA: Springer, 2006.
4. P. Joshi, *Artificial Intelligence with Python*, 1st ed. Birmingham, UK: Packt Publishing Ltd., 2017.

MCE 4152 COLLABORATIVE ROBOTICS [3 0 0 3]

Introduction, Types of Robots, Industrial Robot, Service Robot, Cobots, Custom Robots, Flexible Robots, Industrial robots, Remote programming concept, Camera vision Systems, Different Sensors and actuators, Sensor data Integration, Sensor Data Fusion, Data Acquisitions, Simulations, Environment, Plant models, Payload, Cobot specifications - Shape, Size, Sensitivity, Sophistication, Challenges for testing with cobots, Autonomy Type, Autonomy in Cobot, Scope of cobots, Performance based applications, User based applications, Other Industrial applications, System testing, Assisted testing.

Reference books:

1. P. Matthews and S. Greenspan, *Automation and Collaborative Robotics: A Guide to the Future of Work*, 1st ed. New York, NY, USA: Apress, 2020.
2. C. Urdiales, *Collaborative Assistive Robot for Mobility Enhancement (CARMEN): The Bare Necessities: Assisted Wheelchair Navigation and Beyond*, 1st ed. Berlin, Germany: Springer, 2012.
3. J. Doe, *Collaborative Robots: A Guide to the Future of Automation*, 1st ed. New York, NY, USA: Publisher, 2005.
4. T. L. Brown, *Robotics and Automation Handbook*, 1st ed. Boca Raton, FL, USA: CRC Press, 2005.

MCE0004 SENSOR TECHNOLOGIES [3 0 0 3]

Introduction to sensor technology, classification, and operating principles of various sensors such as temperature, pressure, optical, and chemical sensors, signal processing techniques, including amplification, filtering, and analog-to-digital conversion, alongside calibration methods and error analysis, MEMS (Micro-Electro-Mechanical Systems) sensors, smart sensors, and their integration with IoT (Internet of Things) systems, emerging technologies in nanotechnology based sensor, bio-sensors, sensor for automotive, healthcare, and environmental monitoring, sensor calibration, system design, and data acquisition and industry applications in sensor technology.

Reference books:

1. Z. Altintas and A. Barhoum, *Advanced Sensor Technology: Biomedical, Environmental, and Construction Applications*, Elsevier Science, 2022.
2. Z. Altintas and A. Barhoum, *Fundamentals of Sensor Technology: Principles and Novel Designs*, Elsevier Science, 2023.
3. S. Nihtianov and A. Luque, *Smart Sensors and MEMS: Intelligent Sensing Devices and Microsystems for Industrial Applications*, 2018.
4. O. Krejcar, A. Selamat, and P. Brida, *Smart Sensor Technologies for IoT*, MDPI AG, 2021.

MCE0005 SMART AGRICULTURE [3 0 0 3]

Introduction to IoT enabled technologies in agriculture, sensors, devices and analytics for agriculture applications, Big data and predictive analytics in Agriculture. IoT-enabled Farm technologies and devices, precision agriculture basics and advancements. Real-time Monitoring and Control for Smart Farming.

Reference books:

1. G. Patel, A. Rai, N. N. Das, and R. P. Singh, *Smart Agriculture*, CRC Press, 2021.
2. R. Singh, A. Gehlot, B. Singh, and S. Choudhury, *Internet of Things (IoT) Enabled Automation in Agriculture*, New India Publishing Agency, 2019.

MCE4170 INTERNSHIP (INDUSTRY OR RESEARCH) [0 0 2 1]

Each student must undergo industrial training for a minimum period of 4 month. This may be taken in a phased manner during the vacation starting from the end of six semester. Student must submit to the department a training report in the prescribed format and make a presentation of the same. The report should include the certificates issued by the industry.

SYLLBUS OF HONORS ELECTIVES

MCE3181 RESEARCH METHODOLOGY [1 0 0 1]

Mathematical tools for analysis, statistical analysis of data, regression analysis, correlation, Design of experiment definition, factorial design, designing engineering experiments, Engineering Optimization definition, basics of nonlinear optimization, formulation of optimization problems and case studies

References:

1. C. R. Kothari, *Research Methodology: Methods and Techniques*, New Age International Publication Ltd.
2. J. W. Creswell, *Research Design*, Sage South Asia Edition.
3. D. G. Montgomery, *Design and Analysis of Experiments*, John Wiley India Edition.
4. S. Melville and W. Guddard, *Research Methodology: An Introduction for Science & Engineering Students*.
5. G. M. J. P. Publishers, *Research Methodology for Engineers*, Chennai, 2019.

MCE3281/MCE3290 ROBOTICS AND ITS CONTROL [3 0 0 3]

Introduction, Classification of control Systems, Open loop and Closed loop Control System, Feedback Control System, Proportional (P), Integral (I) and Derivative (D) Blocks, PID controller design, Case Study of PID Controller, Control strategies for robotics, Advanced control methods: Adaptive, robust, and optimal control, Model Predictive Control (MPC) in robotics, ROS, Sensors and Perception in Robotics, Robot Control System Components, Deep Learning concept in Robotics, Transfer Function, Poles and Zeros, Closed Loop Transfer Function, First Order Systems.

Reference book:

1. K. Ogata, *Modern Control Engineering*, Upper Saddle River, NJ, USA: Prentice Hall, 2020.
2. G. F. Franklin, J. D. Powell, and A. Emami-Naeini, *Feedback Control of Dynamic Systems*, Upper Saddle River, NJ, USA: Prentice Hall, 2019.
3. B. C. Kuo, *Automatic Control Systems*, 9th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2009.
4. E. I. Umez-Eronini, *System Dynamics and Control*, Boston, MA, USA: Thomson Engineering, 1999.

MCE4181 SMART MANUFACTURING [3 0 0 3]

Definition and scope of Smart Manufacturing, Evolution of manufacturing technologies, Industry 4.0 principles and components, Overview of traditional vs. smart factories, Internet of Things (IoT) and its applications in manufacturing, Artificial Intelligence and Machine Learning in process optimization, Big Data Analytics for predictive and prescriptive maintenance, Robotics and Automation in smart production lines, Understanding digital twins and their role in manufacturing, Cyber-Physical Systems (CPS) and their architecture, Case studies on CPS implementation in manufacturing, Data acquisition and sensor technologies, Statistical methods and data visualization, Process optimization using real-time data, Case studies: Manufacturing analytics in action, 3D printing technologies.

Reference Books:

1. M. Soroush, M. Baldea, and T. F. Edgar, *Smart Manufacturing: Concepts and Methods*, Elsevier, 2020.
2. A. Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress, 2016.

MCE4182 AI-BASED CONTROLLERS [3 0 0 3]

AI Basics, AI in Control Systems: Overview of Artificial Intelligence and its applications in control systems, Basics of machine learning, neural networks, and fuzzy logic for control, Advantages of AI-

based controllers over traditional controllers; Neural Networks in Control Systems: Basics of artificial neural networks (ANN), Types of neural networks: Feedforward, recurrent, and convolutional neural networks; Fuzzy Logic Controllers: Introduction to fuzzy logic and fuzzy sets, Fuzzy inference systems: Mamdani and Sugeno models, Design and implementation of fuzzy logic controllers; Reinforcement Learning in Control: Fundamentals of reinforcement learning (RL), Markov Decision Processes (MDPs, Q-learning and deep reinforcement learning for control systems; Evolutionary Algorithms in Control Design: Genetic algorithms and particle swarm optimization; Applications and Case Studies: AI-based controllers in robotics, industrial automation, and automotive systems, Predictive control for energy systems and smart grids, AI in medical devices and assistive technologies.

Reference Books:

1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed., Elsevier, 2011.
2. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction*, 2nd ed., MIT Press, Cambridge, MA, 2018.
3. W. Ertel, *Introduction to Artificial Intelligence*, 3rd ed., Springer, 2025.

MCE4191 WHEELED ROBOTS [3 0 0 3]

Types of wheeled mobile robots: Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots. Sensors for mobile robot navigation, Introduction to modern mobile robots: Swarm robots, cooperative and collaborative robots, mobile manipulators, autonomous mobile robots.

Reference books:

1. R. Siegwart, I. R. Nourbakhsh, and D. Scaramuzza, *Introduction to Autonomous Mobile Robots*, MIT Press, USA, 2011.
2. S. G. Tzafestas, *Introduction to Mobile Robot Control*, Elsevier, USA, 2014.
3. Kelly, *Mobile Robotics: Mathematics, Models, and Methods*, Cambridge University Press, USA, 2013.
4. S. Thrun, W. Burgard, and D. Fox, *Probabilistic Robotics*, MIT Press, USA, 2005.
5. G. Dudek and M. Jenkin, *Computational Principles of Mobile Robotics*, Cambridge University Press, USA, 2010.

MCE4192 ADVANCE ROBOTICS AND APPLICATIONS [3 0 0 3]

Introduction, transformations, DH Parameters, Forward and Inverse Kinematics, redundancy resolution, Velocity kinematics and Jacobian, Singular value decomposition, singularity and manipulation ability, Trajectory planning , dynamic, Sensors and actuators as used in robotics, Basics of linear control – PD, PID controller, model based control, stability, Multi finger grasping – form, force closures, grasp matrix, Locomotion – active and passive walkers, concepts of balance, Biped Gait and Balance using ZMP, kinematics and dynamic modeling of walk, Design and Optimization of legged mechanisms. Robotics Applications.

Reference books:

1. S. B. Niku, *An Introduction to Robotics: Analysis, Systems, Applications*, Prentice hall, 2019.

2. M. Wilson, *Implementation of Robot Systems - An Introduction to Robotics, Automation, and Successful Systems Integration in Manufacturing,* Elsevier, 2015.
3. J. J. Craig, *Introduction to Robotics: Mechanics and Control*, Pearson, 2013.
4. M. Mihelj, T. Bajd, A. Ude, J. Lenarcic, A. Stanovnik, S. Slajpah, M. Munih, and J. Rejc, *Robotics*, Springer, 2019.
5. Winfield, *Robotics: A Very Short Introduction*, Oxford Academic, 2012.